Highly-Efficient Models of the Dynamic Solar Corona
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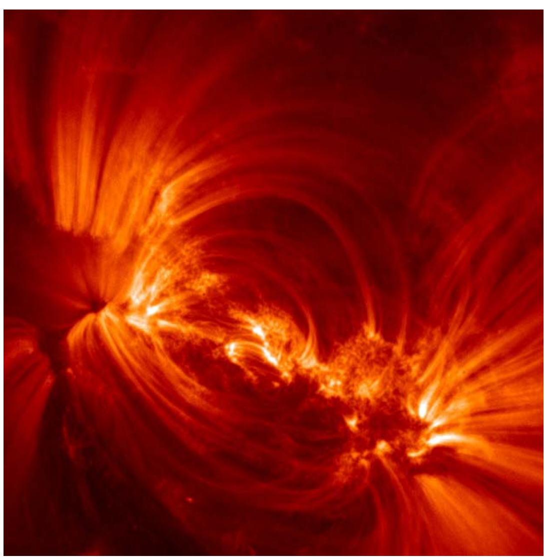
X-ray and UV radiation from the solar corona---the Sun's multi-million degree outer atmosphere---controls the ionization, dynamics, and chemistry of the Earth's upper atmosphere. It affects radio signal propagation and satellite drag and can severely impact space-based technological systems in both the military and civilian sectors. Physics-based models of the solar corona are required to mitigate the effects of the variable radiation with a desired level of reliability. This involves numerical simulations of hundreds of thousands of magnetically-confined "coronal loops" that are the basic building blocks of the corona. Early attempts to model loops as static structures proved entirely inadequate, and it is now recognized that loops are impulsively heated by "nanoflares" and are highly dynamic. However, a single loop simulation requires nearly one day of computer time on the fastest processors, so modeling the entire corona has been entirely out of the question. We have recently made a breakthrough. We have developed a method to solve a simplified set of physical equations that produces excellent approximations to the exact solutions and does so ten thousand times more quickly! Modeling the full corona and predicting the variable X-ray and UV input to the terrestrial atmosphere is now well within reach. The attached EUV image from NASA's TRACE satellite shows a close-up of a solar active region and reveals a multitude of coronal loops. The accompanying plots show the evolution of temperature, density, and pressure in a nanoflare-heated loop as given by our new method (solid) and the exact solution (dashed).



(Klimchuk et al, 2006, in ESA SP-617, Proceedings of SOHO-17: Ten Years of SOHO and Beyond, ed. H. Lacoste,(Noordwijk: ESA), ISBN 92-9092-928-6, ISSN 1609-042X, S16)